Appendix A Assimilative Capacity Study

Stantec

Assimilative Capacity Study – Mississippi River at Carleton Place

Final Report

August 15, 2022

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Executive Summary

The Town of Carleton Place is looking to upgrade their existing Wastewater Treatment Plant which discharges to the Mississippi River. In order to support the upgrades, an Assimilative Capacity Study was requested to be undertaken to determine the appropriate effluent limits and mixing zone for the facility. This report provides a review of receiving water quality and water quantity of the Mississippi River with respect to the proposed discharge limits of the Wastewater Treatment Plant. A dilution-mixing scenario for the plant with conservative ambient and effluent conditions was run using a CORMIX model to assess the effluent dilution potential when discharged to the Mississippi River. Based on the results of this assessment, Stantec has identified proposed effluent limits suitable for the facility and the receiving environment.

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Acronyms / Abbreviations

AC	Assimilative Capacity
CBOD	Carbonaceous Biological Oxygen Demand
C of A	Certificate of Approval
DO	Dissolved Oxygen
ECA	Environmental Compliance Approval
MECP	Ministry of the Environment, Conservation and Parks
MLD	Million Litres a Day
MOEE	Ministry of Environment and Energy
TAN	Total Ammonia Nitrogen
TP	Total Phosphorous
TSS	Total Suspended Solids
PWQO	Provincial Water Quality Objectives
WWTP	Wastewater Treatment Plant
WSC	Water Survey of Canada
WWTP	Wastewater Treatment Plant

1 Introduction

The Town of Carleton Place (the Town) in consultation with the Ministry of the Environment, Conservation and Parks (MECP) has identified a need to update the Assimilative Capacity (AC) Study of the Mississippi River at the effluent discharge location of the Carleton Place Wastewater Treatment Plant (WWTP). The previous AC study was prepared by Stantec Consulting Ltd. (Stantec) in 2009 (Stantec 2009). In 2022, the Town retained Stantec to conduct an updated AC study in support of their proposed WWTP upgrades.

The Carleton Place WWTP is operated under the Amended Certificate of Approval (C of A) #5001-7FZT4A (dated October 3, 2008) and is a conventional activated sludge plant with anaerobic digestion. The C of A is currently referred to as an Environmental Compliance Approval (ECA). Chemicals are added for phosphorus removal and alkalinity adjustment. Effluent is then ultraviolet disinfected prior to discharge to the Mississippi River. Three physical/chemical clarifiers are available and can be brought online during periods of heavy wet weather where flows exceed 10,400 cubic metres per day. The effluent outfall is located on the right bank of the Mississippi River about 200 m from the plant immediately upstream of McNeely Avenue Bridge. The existing ECA effluent limits and objectives include total ammonia nitrogen (TAN), Total Phosphorus (TP), Carbonaceous Biological Oxygen Demand (CBOD), Total Suspended Solids (TSS), *E.coli* and pH.

The Mississippi River is a tributary of the Ottawa River in eastern Ontario. The Town of Carleton Place is situated in Lanark County (west of the City of Ottawa) and accessed by Provincial Highways #7 and #15. Carleton Place has a population of 12,517 (Canada Census 2021) with 5,876 private dwellings on 12.47 km^2 of land. The community provides municipal water and sewer services. The Mississippi River runs through the center of town and serves as both the source of water for municipal use, as well as the receiving stream for ultimate disposal of the treated sewage effluent. The Mississippi River is used for recreational purposes in the area around Carleton Place. A map of the study area is provided in **Figure 1** in **Appendix A**. The WWTP discharge is located downstream from the Drinking water plant intake.

2 Regulatory Framework

In Ontario, a receiving water-based approach is used to establish site-specific effluent criteria enforced through the *Ontario Water Resources Act,* Section 53 (Sewage Works) Environmental Compliance Approval (ECA) for Industrial Sewage Works. The procedure for developing receiver-based effluent criteria is through a receiving water assimilative capacity assessment as described in the Ontario Ministry of Environment and Energy (MOEE, now known as MECP) Procedure B-1-5 (MOEE 1994a) and Water

Management – Policies, Guidelines and Provincial Water Quality Objectives (MOEE, 1994 & 1999).

Based on these guiding documents the key criteria of an AC study are the following:

- Receiving water low flow (i.e., 7Q20 flow – the minimum 7-day average low flow with a recurrence period of 20 years;
- Receiving water quality (e.g., 75^{th} percentile of background concentrations);
- Maximum expected effluent discharge rate;
- Maximum expected effluent parameter concentrations;
- Receiving water Policy Type (i.e., Policy 1 Receiver or Policy 2 Receiver); and
- Effluent criteria (flow rates and concentrations) to be developed from the results of a receiving water AC assessment.

Through the results of the AC Study, a mixing zone is defined. The MECP guiding principles for defining mixing zones are the following:

- Size and extent to be kept as small as reasonably and practically possible;
- Mixing zones must not interfere with beneficial uses of the surface water body;
- Mixing zones must not result in toxic conditions; and,
- Mixing zone boundary is defined by the downstream point where effluent assimilation returns the receiver's water quality to either background concentrations or the Ontario Provincial Water Quality Objectives (PWQO).

3 Water Quantity

3.1 Receiver Hydrology

The Water Survey of Canada (WSC) station on the Mississippi River at Appleton (station ID 02KF006) has monitored flow and water level data since 1918 (**Table 3.1**). This station is located approximately 5 km downstream from the Carleton Place WWTP outfall. The Carleton Place Dam is located approximately 900 m upstream of the Carleton Place WWTP outfall and provides flow attenuation for the downstream section of the Mississippi River. No major water gaining sources (e.g., tributaries) or losing sources (e.g., water intakes) are noted between the outfall and the WSC gauge. The 7Q20 is recommended by the MECP Procedure B-1-5 (MOEE 1994) as the low flow statistic for the assessment of receiving waters for point source effluent. Therefore, the 7-day average minimum flow for a return period of 20 years (7Q20) is considered to be applicable for assimilative capacity calculations completed for the WWTP outfall.

Table 3.1 Appleton WSC Hydrometric Station Information

Station Name	Mississippi River at Appleton
Station ID	02KF006
Latitude	45°10’34” N
Longitude	76°07’24” W
Basin Area (km^2)	2,940
Record Period	1918-2020
Record Length (years of data)	103
Regulation Type	Regulated (dam)

The Appleton WSC station daily flow data was used to calculate the 7-day moving average from 1919 to 2020, a data range of 102 years. The year 1918 and 2021 were excluded from the 7-day averages due to an incomplete data set for the full year. The minimum 7-day average flow for each year between 1919-2020 were used as inputs into the Hydrologic Frequency Analysis (HYFRAN) version 1.1 software. This software is used to fit statistical distributions for flood and drought conditions and to predict flows at various return periods. The drought condition was modelled under a Log-Pearson Type III distribution using the method of moments, which provides a conservative estimation of drought flows. The statistical analysis identified that the Appleton station’s 20-year return period for the 7-day average minimum flow (7Q20) was estimated to be 3.96 m^3/s. Other low flow statistics for station 02KF006 were calculated for comparison and are presented in **Table 3.2**. The five lowest flows on records were observed in 2016, 2001, 1999, 2019 and 2002, and were observed within the last 21 years since the station was installed in 1918. The lowest year on record was 2016 with a 7-day average minimum flow of 2.2 m^3/s.

Table 3.2 Appleton WSC Hydrometric Station Information

Statistics	Flow, m^3/s
7Q20	3.96
7Q10	4.45
7Q2	6.75

Using GIS and provincial DEM, the difference in drainage area between the WWTP outfall and the Appleton WSC station was determined to be 58 km^2. The total area of the Mississippi River watershed at the Appleton WSC station is 2,940 km^2. The 7Q20 flow at the WWTP was calculated using a linear area proration method for the smaller drainage area. The final 7Q20 flow used in this assessment was 3.88 m^3/s.

3.2 Effluent Flow Rate

The Carleton Place WWTP has a continuous discharge through a series of six diffusers located on an underwater outfall pipe which extends about twenty metres into the Mississippi River. Location of the outfall and diffuser design are presented in **Appendix B**.

The current ECA stipulates that the best efforts should be used to maintain rated capacity of the plant at 7,900 m^3/day (0.091 m^3/s) during dry weather conditions and 22,000 m^3/day (0.255 m^3/s) during wet weather conditions.

The new proposed maximum daily effluent flow of the upgraded WWTP for any weather conditions is 37,188 m^3/day (0.430 m^3/s). The proposed discharge location of the six diffusers is not proposed to change with WWTP upgrades. The existing diffuser can accommodate increase in flow.

4 Water Quality

4.1 Receiver Water Quality

Surface water quality in the Mississippi River is currently monitored at three locations within the vicinity of the Carleton Place WWTP: two sites upstream of the WWTP and one downstream. Upstream of the WWTP, water samples have been collected by Mississippi Valley Conservation Authority (MVCA) since 2019 at Fergusons Falls (at Fergusons Falls Road bridge) and from four sites within Mississippi Lake (lake inlet, near Burnt Island, near Pretties Island, and lake outlet). Water quality data was provided by MVCA for the monitoring conducted at these two sites for samples collected in 2019-2021.

MVCA also collects water quality samples on the Mississippi River downstream of the Carleton Place WWTP at a monitoring site which corresponds to Ontario Provincial Water Quality Monitoring Network (PWQMN) Appleton Station (Station ID:18343006102). This PWQMN station has been operated since 1983 and located in Appleton, ON at the Wilson Street bridge. The Appleton station characterises water quality in the Mississippi River downstream of the WWTP.

Water quality parameters monitored in Mississippi Lake are limited to pH, phosphorus and water temperature for single samples taken in May, July and September of 2019-2021. Data for TAN, CBOD, TSS, *E.coli* and DO were not provided for the lake. Also, equipment malfunction is suspected for samples taken on July 9, 2019. As data in Mississippi Lake are insufficient to derive statistics for the purpose of this assessment, the water quality data from Fergusons Falls was used to characterize water quality upstream of the WWTP outfall.

Based on the data sets described above, a water quality table has been prepared for select parameters of concern. In this data analysis, analytical results that were identified as below the detection limit were assigned a sample value of half the detection limit as per standard analytical practice. Where sample sets were analysed using multiple analytical methods for one parameter, the highest resulting value was utilized in the data analysis.

Water quality data for 2019-2021 for Fergusons Falls are summarised in **Table 4.1** for monthly average and the annual 75th percentile. The annual 75th percentile was calculated based on all available individual samples, not based on monthly averages.

The summary parameters provided in these tables are the parameters of potential concern (TAN, total phosphorous, TSS, *E.coli*) listed in the WWTP ECA or parameters which have direct impact on parameters of concern (DO, pH and temperature).

CBOD data are not available for any of the three monitoring stations.

Table 4.1 Monthly Average Water Quality for 2019-2021 (Ferguson Falls)

Month	Total Ammonia Nitrogen (TAN), mg/L	Field pH	Total Phosphorous (TP), mg/L	Total Suspended Solids (TSS), mg/L	Water Temperature, °C	*E.coli* - Total (CFU/ 100 ml)	Field Dissolved Oxygen (DO), mg/L
April	0.008	7.46	0.020	3	9.2	5	11.1
May	0.015	6.98	0.018	3.5	18.6	13	8.9
June	0.012	7.44	0.016	1.5	21.9	13	-
July	0.010	6.98	0.012	1	25.0	9	7.2
August	0.013	6.66	0.009	1	22.9	11	7.4
September	0.012	7.42	0.013	1.7	17.7	13	8.4
October	0.010	6.73	0.011	1.7	8.8	48	11.2
November	0.006	7.46	0.009	1	1.5	14	15.0
75^{th} Percent	0.014	7.63	0.016	2	22.3	13	7.6*
# of Samples used to derive 75^{th} Percentile	20	19	20	21	20	20	15

Notes:

No data for December-March

– = no data available

* = 25^{th} percentile

Monthly average TAN concentrations vary between 0.006 and 0.015 mg/L. Monthly average pH concentrations vary between 6.66 and 7.46. TSS concentrations are generally very low, they vary from 1 to 3.5 mg/L. Water temperature data show expected seasonality with the lowest temperature in winter-spring months and highest in summer months.

Total phosphorus concentrations are below the Provincial Water Quality Objectives (PWQO) (0.03 mg/L for rivers) for all months at both stations. The 75^{th} percentile at Ferguson Fall is 0.016 mg/L. Therefore, the Mississippi River is a Policy 1 receiver with respect to total phosphorus. The Mississippi River is also a Policy 1 receiver for other parameters of concern (i.e., un-ionized ammonia, pH, and *E.coli*).

4.2 Current Effluent Water Quality Limits

The Carleton Place WWTP is operated under the Amended ECA#5001-7FZT4A (dated October 3, 2008). Condition 7 of the ECA establishes compliance limits to ensure that the effluent discharged from the Works to the Mississippi River meets the Ministry's effluent quality requirements thus minimizing environmental impact on the receiver and to protect water quality, fish and other aquatic life in the receiving water body. The effluent limits are presented in **Table 4.2**.

Table 4.2 Monthly Average Effluent Limits

Effluent Parameter	Average Concentration, mg/L	Average Loading, kg/day
CBOD5	25.0	550
Total Suspended Solids	25.0	550
Total Phosphorus	1.0	22.0
TAN (Ammonia + Ammonium) Nitrogen	4.0 (May 15 to Sept. 30)	88.0 (May 15 to Sept. 30)
pH	6 - 9.5	---

5 Mixing Zone Assessment

An AC assessment for the Mississippi River as the ultimate receiver was completed to determine the assimilative capacity and mixing potential of the river during the WWTP effluent discharge.

Near-field modelling in the Mississippi River was performed using CORMIX, Version 12.0. CORMIX is a United States Environmental Protection Agency supported mixing zone model and decision support system for environmental impact assessment of regulatory mixing zones resulting from point source discharges (Doneker and Jirka 2017). The system can be used for the analysis, prediction, and design of aqueous toxic or conventional effluent discharges into diverse waterbodies. The major emphasis is on the geometry and dilution / assimilation characteristics of the initial mixing zone. The basic CORMIX methodology relies on the assumption of steady state ambient conditions, meaning CORMIX generates an instantaneous prediction of the effluent plume or mixing zone from the discharge point. The near-field CORMIX model incorporates effluent outfall design and provides a high resolution of effluent mixing.

5.1 Model Input

The required model inputs for the receiving environment include stream geometry, water temperature, flow, and water depth. Average water depths for the outfall locations and over the plume length were estimated based on available bathymetry information and design drawings (**Appendix B**).

Bottom roughness in CORMIX is expressed as Manning's "n" and converted internally to a friction factor based on average water depth. The friction factor has limited impact on modelling results and is important mostly for far-field diffusion. A Manning's n value of 0.03 was selected for use in the model based on available information about bottom sediments (gravel with small rocks and vegetated banks) and recommendations received from MVCA..

Wind is not a sensitive variable in near-field mixing modelling. Wind is non-directional in CORMIX and it is used for surface heat transfer and ambient mixing only. A mean annual wind speed of 2.3 m/s was used in the model, and it was derived based on historical wind data (1991-2020) rom Appleton Station (EC Station # 6800285).

The receiving water and effluent were assumed to be freshwater with an average annual water temperature of 15.9 degrees Celsius (°C) as per Appleton PWQMN Station 18343006102 (2017-2021). For un-ionized ammonia calculations, the worst-case summer temperature was used as further described in **Section 6.2**.

CORMIX's input parameters, which characterize the effluent, ambient environment, and outfall design, are summarized in **Table 5.1**.

The conservative modeling conditions are based on peak effluent flow conditions, maximum effluent concentrations, a 7Q20 flow in the receiver, and the 75th percentile of background water quality using upstream water quality derived from the Ferguson Fall monitoring station. Additionally, a conservative assumption of no biochemical decay or first order rate reduction was made in CORMIX. Decay can happen naturally due to sedimentation, bioaccumulation and reduction/oxidation kinetics in the mixing zones.

Table 5.1 CORMIX Input Parameters

Parameter, units	Low Flow Conditions	Comments/Data Source
Effluent Flow Rate, m^3/s	0.43	Maximum daily flow as per proposed design (~37MLD)
Ambient 7Q20 Flow, m/s	3.88	See Section 3.1
Water Temperature, ˚C	25.0	July water temperature at Ferguson Falls
Receiver Average Depth, m	1.0	Bathymetry Map
Receiver Width, m	40	Main channel width based on GIS

Parameter, units	Low Flow Conditions	Comments/Data Source
Manning's n	0.03	Assumed based on bottom roughness and MVCA comments
Average Wind Speed, m/s	2.3	Climate Station # 6800285
Length of diffuser, m	10	Outfall Design Drawings
Offshore Distance, m	10	Offshore distance to diffuser
Number of ports	6	Outfall Design Drawings
Port Spacing, m	2	Outfall Design Drawings
Port Height, m	0.3	Outfall Design Drawings
Port Diameter, m	0.2	Outfall Design Drawings
Alignment Angle (Gamma)	90º	Angle between current direction and diffuser
Vertical Angle (Theta)	0º	Angle between port centerline and river bed
Horizontal Angle (Sigma)	0º	Angle between current direction and plan projection of the port centerline

5.2 Modelling Assumptions

The following assumptions for the modeling investigation were made in the dilution and mixing study:

- Steady ambient and effluent conditions were assumed in CORMIX;
- Outfall configuration (vertical angle, horizontal angle, diffuser type) was based on available design drawings;
- CORMIX parameters (Manning's n, wind speed, ambient and effluent density) were derived based on available field data and literature;
- Bathymetry information for the river was derived based on design drawings.
- Modelling was conservatively focused on dilution-mixing ratios and ignoring decay/bioaccumulation/sedimentation.

6 Results and Discussion

6.1 CORMIX Results

A dilution-mixing scenario with conservative ambient and effluent conditions was run using a CORMIX model. The results for the WWTP effluent dilution modelling are presented in **Table 6.1**. The geometry of the effluent diffuser (6 nozzles over 10 m) and location (middle of the main river channel) provide substantial initial mixing and dilution. The effluent is fully mixed with the ambient environment at 63 m from the diffuser.

Table 6.1 CORMIX Dilution Ratios

Downstream distance, m	5 m	10 m	20 m	50 m	63 m	100 m
Dilution Ratio, times (Total River Flow to Effluent Flow)	6.3	6.7	7.4	7.8	10.0	10.0

Figure 2 in **Appendix A** presents the plan view of the effluent plume concentration, assuming an arbitrary initial effluent concentration of 100 mg/L for an arbitrary parameter prior to discharge. The plume shows rapid mixing within a few meters from the outfall. **Figure 2** also presents the plume concentration and dilution ratios along the downstream distance from the outfall.

6.2 Proposed Effluent Criteria

Based on the results of the modelling presented in **Section 6.1**, effluent parameters and concentrations were developed based on the assimilative capacity of the receiving environment.

The PWQOs do not contain references to TSS criteria. It is proposed to reduce the monthly average TSS limit from 25 mg/L to 15 mg/L while keeping the total load very close to the existing ECA. This reduced TSS limit is expected to be achievable based on the proposed treatment.

The proposed objective for pH was selected as the PWQO range (6.5-8.5) and pH effluent limits are proposed identical to the current ECA limits.

Phosphorus is a limiting nutrient for algal growth in rivers and lakes. The PWQO for TP in riverine environments is 30 µg/L and it is intended to prevent the growth of algae. Total phosphorus is not toxic to aquatic life but excess concentrations can lead to changes in aquatic ecosystems (e.g., reduced biodiversity, reduced oxygen conditions, toxic algae blooms, impaired aesthetics and recreational opportunities). It is proposed to reduce the existing phosphorus limit from 1 mg/L to 0.3 mg/L and reduce total phosphorus load from 22 kg/day to 11.1 kg/day. It was noted that current phosphorus load from the Carleton Place WWTP does not substantially increase phosphorus concentrations downstream in the Mississippi River i.e., the upstream 75th percentile is 0.016 mg/L vs downstream of 0.017 mg/L (**Table 4.1** and **Appendix C)**. The 0.3 mg/L of phosphorus for the proposed plant is protective of the environment, reduces phosphorus load in comparison with current conditions and is in line with the MECP design consideration for sewage treatment plants with phosphorus removal and filtration.

Carbonaceous Biochemical Oxygen Demand (CBOD) refers to the amount of oxygen that would be consumed if all organic material in one litre of the effluent were oxidized. CBOD directly affects the amount of dissolved oxygen (DO) in the effluent mixing zone. The greater the CBOD, the more rapidly oxygen is depleted. This means less oxygen is available to higher forms of aquatic life. It is proposed to reduce the CBOD limit from 25 mg/L to 15 mg/L, keeping the total load very close to the existing ECA limits. The reduced CBOD limit is expected to be achievable based on the proposed treatment. The modeling result shows that CBOD concentrations will reduce to background concentrations within 63 m from the outfall. Therefore, effects of CBOD on dissolved oxygen concentrations in the mixing zone is very small. This conclusion is supported with the current observed dissolved oxygen concentrations upstream and downstream of the Carleton Place WWTP (**Table 4.1** and **Appendix C**). Morphology and slope of the Mississippi River downstream of the dam provide well flow mixing and high DO saturation.

DO in the Mississippi River downstream of the outfall was modelled using an oxygen sag assessment. The 25th percentile value of ambient DO (7.6 mg/L), summer water temperature and BOD were used for analysis. CBOD in the effluent is 15 mg/L. The 7Q20 flow (3.88 m^3/s), corresponding velocity (0.097 m/s) and river depth were used. The reaeration coefficient (kr) and deoxygenation rate (kd) were calculated based on river characteristics. The modelling results indicate that DO drops from 7.6 mg/L to 6.84 mg/L immediately at the outfall, that is above the PWQO of 4 mg/L. Then, DO is slowly increasing and reaches the ambient levels 1,050 m downstream of the outfall.

E.coli refers to a large group of bacteria that are commonly found in the intestines of mammals. *E.coli* may be present in WWTP effluent and therefore it was included in this study. A discharge was included in the CORMIX model for *E.coli* at 200 counts /100 ml which is an achievable target for the sanitary treatment plant. The PWQO limit for *E.coli* is 100 counts/100 ml, and the results from the model show that the PWQO limit for *E.coli* is achieved within the immediate vicinity of the treated effluent discharge location (< 5 m).

Total ammonia is the sum of un-ionized ammonia (NH_3) and ionized ammonia (NH_4). Typically, an equilibrium exists between NH_3 and NH_4, which is governed by pH and water temperature. In assimilative capacity studies, un-ionized ammonia is of primary interest as it potentially can be toxic in lower concentrations. Other factors which could indirectly affect un-ionized ammonia include water hydraulics (velocities, cross-sections), meteorological conditions and water alkalinity. Highest monthly summer water temperature of 25.0 degree C is observed in July and highest summer pH of 7.44 is observed in June. The 75th percentile total ammonia concentration upstream of the outfall is 0.014 mg/L. Taking into account dilution immediately downstream of the outfall (< 5 m), the maximum total ammonia concentration of the effluent can be as high as 8 mg/L and still result in an un-ionized ammonia concentration below the PWQO (0.02 mg/L N). In order to be conservative and consistent with the existing ECA, it is proposed to keep the summer TAN limits the same as in the current ECA, i.e., 4 mg/L N and average load of 148 kg/day. These limits are protective of the environment.

The proposed effluent limits and objectives are presented in **Table 6.2**. They are intended to meet the PWQO concentrations within a small mixing zone of less than 100 m. The limits are achievable for the WWTP at the proposed maximum daily flow of 0.43 m^3/s.

Table 6.2 Carleton Place WWTP Monthly Average Effluent Limits

Effluent Parameter	Current Limits		Proposed Objectives	Proposed Limits *	
	Average Concentration, mg/L	**Average Loading, kg/day**	**Average Concentration, mg/L**	**Average Concentration, mg/L**	**Average Loading, kg/day**
CBOD5	25.0	550	10	15.0	557
Total Suspended Solids	25.0	550	10	15.0	557
Total Phosphorus	1.0	22.0	0.2	0.3	11.1
TAN (Ammonia + Ammonium) Nitrogen	4.0 (May 15 to Sep 30)	88.0 (May 15 to Sep 30)	3.0 (May 15 to Sep 30) 6.0 (Oct 1 to May 14)	4.0 (May 15 to Sep 30) 8.0 (Oct 1 to May 14)	148 (May 15 to Sep 30) 296 (Oct 1 to May 14)
pH	6 - 9.5	---	6.5- 8.5	6 - 9.5	---
E.coli	---	---	100 counts / 100 mL	200 counts / 100 mL	---
Acute Toxicity: Rainbow Trout and Daphnia Magna				Non-acutely lethal (not greater than 50% mortality in undiluted effluent)	

* Proposed non-compliance limits

7 Conclusions

An assimilative capacity assessment was completed for the Mississippi River at the effluent discharge location of the Carleton Place WWTP.

Effluent limits for the WWTP treated effluent were proposed and presented in **Table 6.2**. They are protective of the environment and were derived based on the conservative modelling conditions (e.g., very low flows in the receiver and high effluent rate).

The CORMIX model was used for near-field mixing and developing dilution ratios in the immediate vicinity of the treated effluent discharge location. The geometry of the proposed effluent diffuser provides substantial initial mixing and dilution. CORMIX demonstrated full mixing within 63 m downstream of the discharge. Rapid mixing is a result of optimal number of nozzles, their configuration and size as well as diffuser location.

8 Closure

This report has been prepared for the sole benefit of the Town of Carleton Place. This report may not be used by any other person or entity without the express written consent of Stantec Consulting Ltd. and the Town.

Any use that a third party makes of this report, or any reliance on decisions made based on it, are the responsibility of such third parties. Stantec Consulting Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made, or actions taken, based on this report.

The information and conclusions contained in this report are based upon work undertaken by trained professional and technical staff in accordance with generally accepted engineering and scientific practices current at the time the work was performed. Conclusions and recommendations presented in this report should not be construed as legal advice.

The conclusions presented in this report represent the best technical judgment of Stantec Consulting Ltd. based on the data obtained from the work. If any conditions become apparent that differ from our understanding of conditions as presented in this report, we request that we be notified immediately to reassess the conclusions provided herein.

9 References

Doneker, R.L. and Jirka, G.H. 2017. CORMIX User Manual: A Hydrodynamic Mixing Zone Model and Decision Support for Pollutant Discharges into Surface Waters, Report prepared for U.S. Environmental Protection Agency.

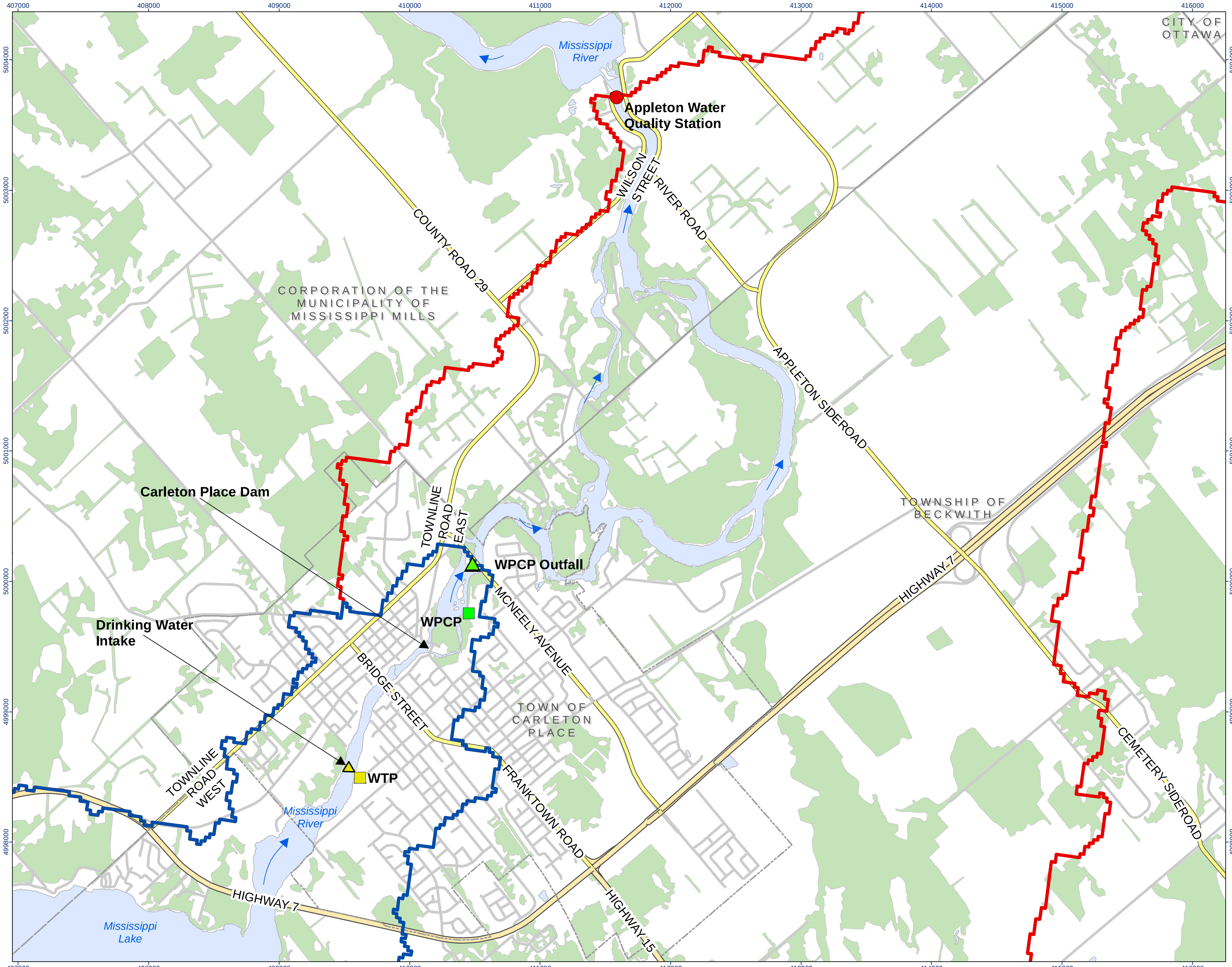
INRS-Eau Terre et Environnement (B. Bobee et al.). 2008. Hydrologic Frequency Analysis (HYFRAN). Version 1.1.

Ministry of Environment & Energy (MOEE) 1994a. Deriving Receiving-Water Based, Point-Source Effluent Requirements for Ontario Waters, Procedure B-1-5, PIBS# 3302, July 1994.

Ministry of Environment & Energy (MOEE) 1994b. Provincial Water Quality Objectives, July 1994.

Stantec 2009 Receiving Water Assessment Review for Carleton Place Water Pollution Control Plant Discharge to Mississippi River, May 20, 2009.

Appendix A
Figures



Stantec

Carleton PLACE

Legend

- Drinking Water Treatment Plant (WTP)
- WTP Intake
- Water Pollution Control Plant (WPCP)
- WPCP Outfall
- Appleton Water Quality Station
- Watershed - WPCP Outfall
- Watershed - Appleton Water Quality Station
- Municipal Boundary
- Highway
- Major Road
- Minor Road
- Waterbody
- Wooded Area

N

0 0.5 1 Kilometers
(At original document size of 11x17)
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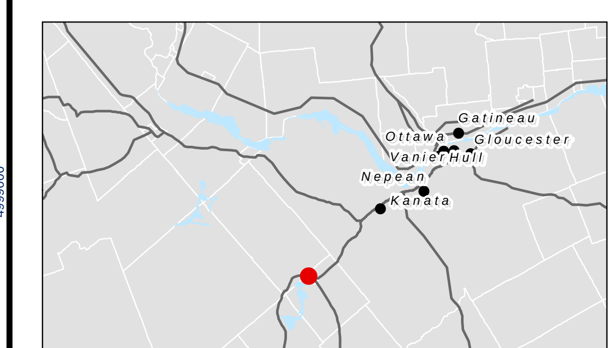
Notes
1. Coordinate System: NAD 1983 UTM Zone 18N
2. Base features produced under license with the Ontario Ministry of Natural Resources and Forestry © Queen's Printer for Ontario, 2021.



Project Location Prepared by CR on 2022-02-14

Carleton Place, ON

Client/Project 163401646 REVA

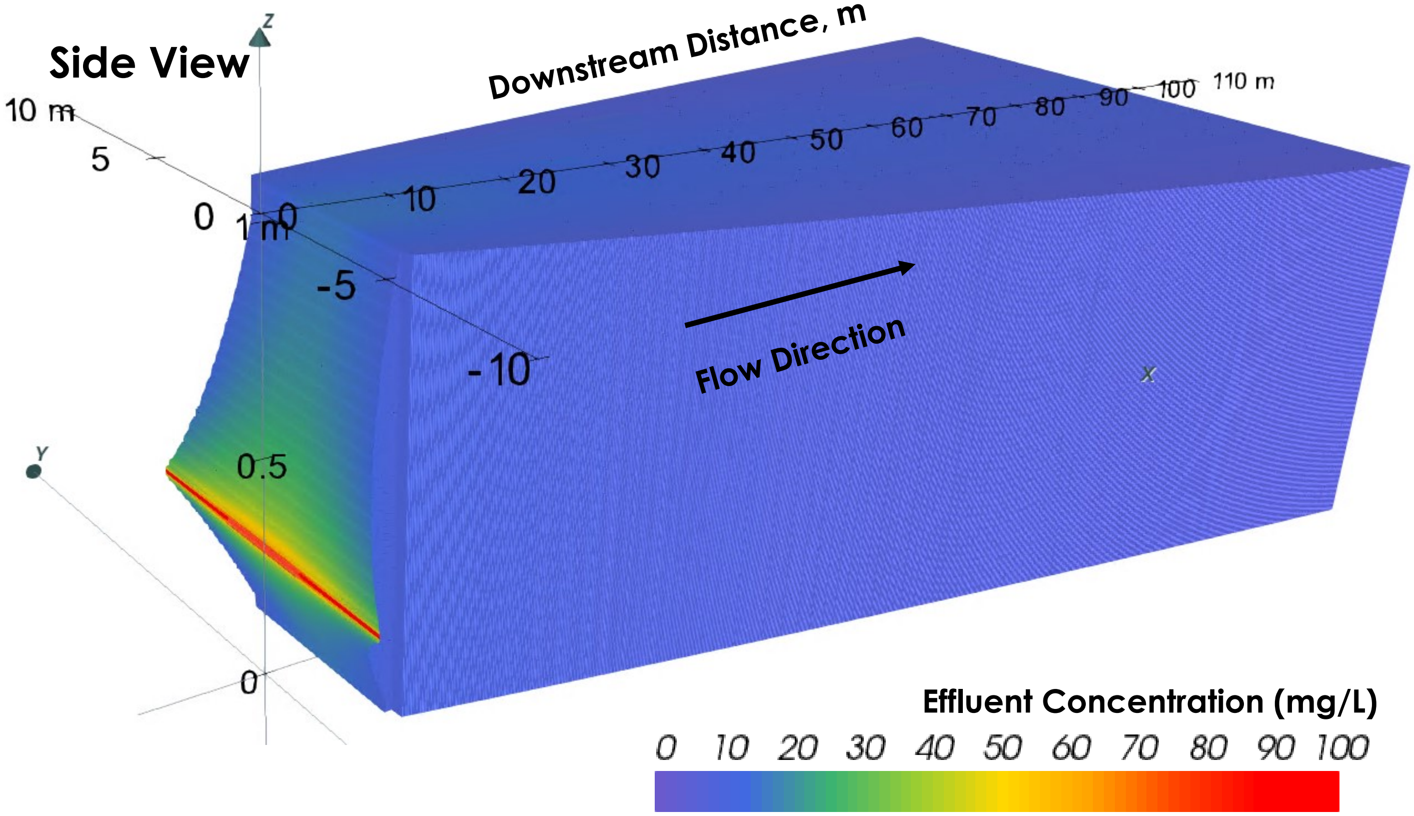
Town of Carleton Place
Carleton Place W&WW Master Plan
Assimilative Capacity Study

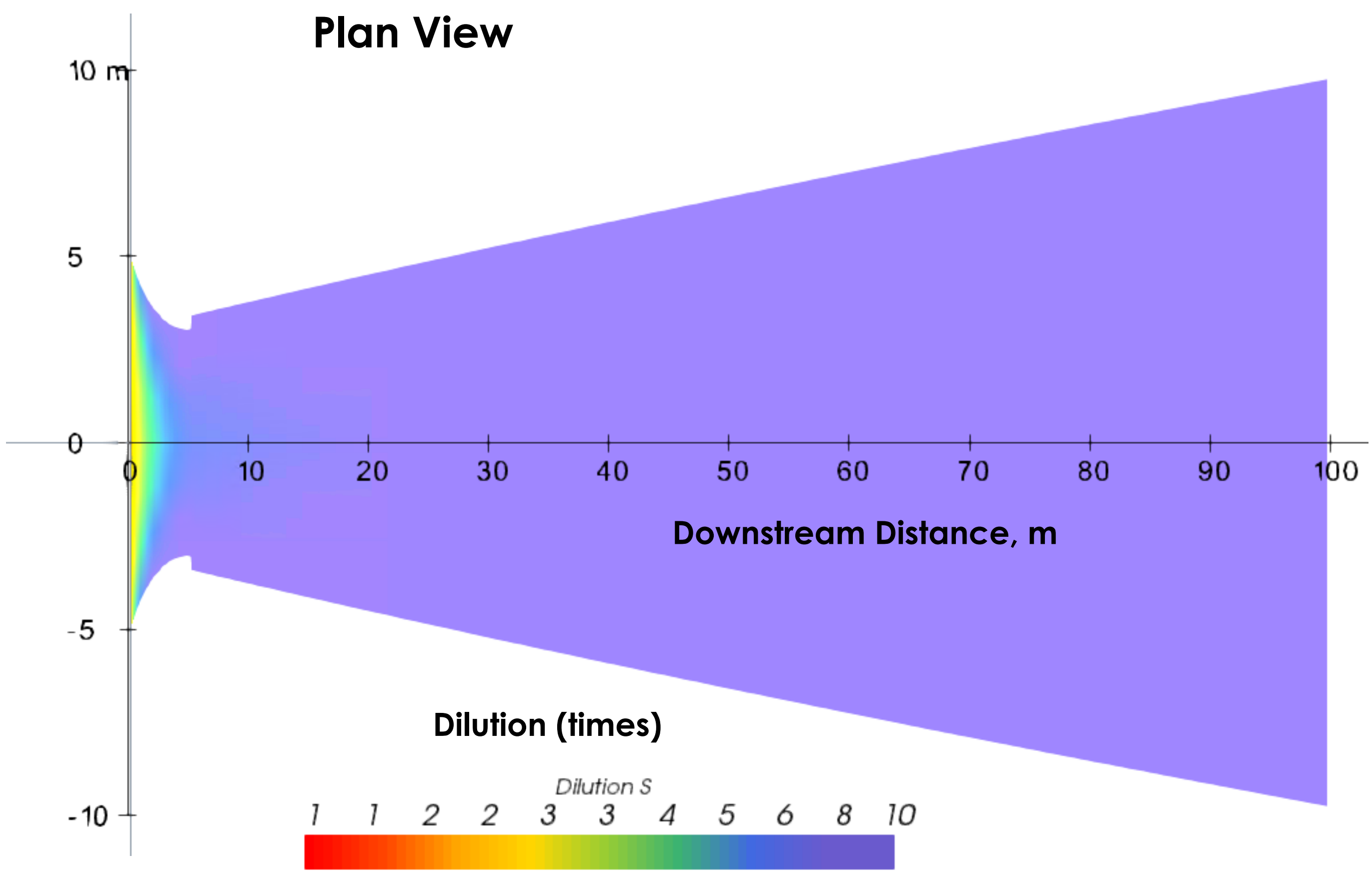
Figure No.
1

Title
Study Area & Watersheds

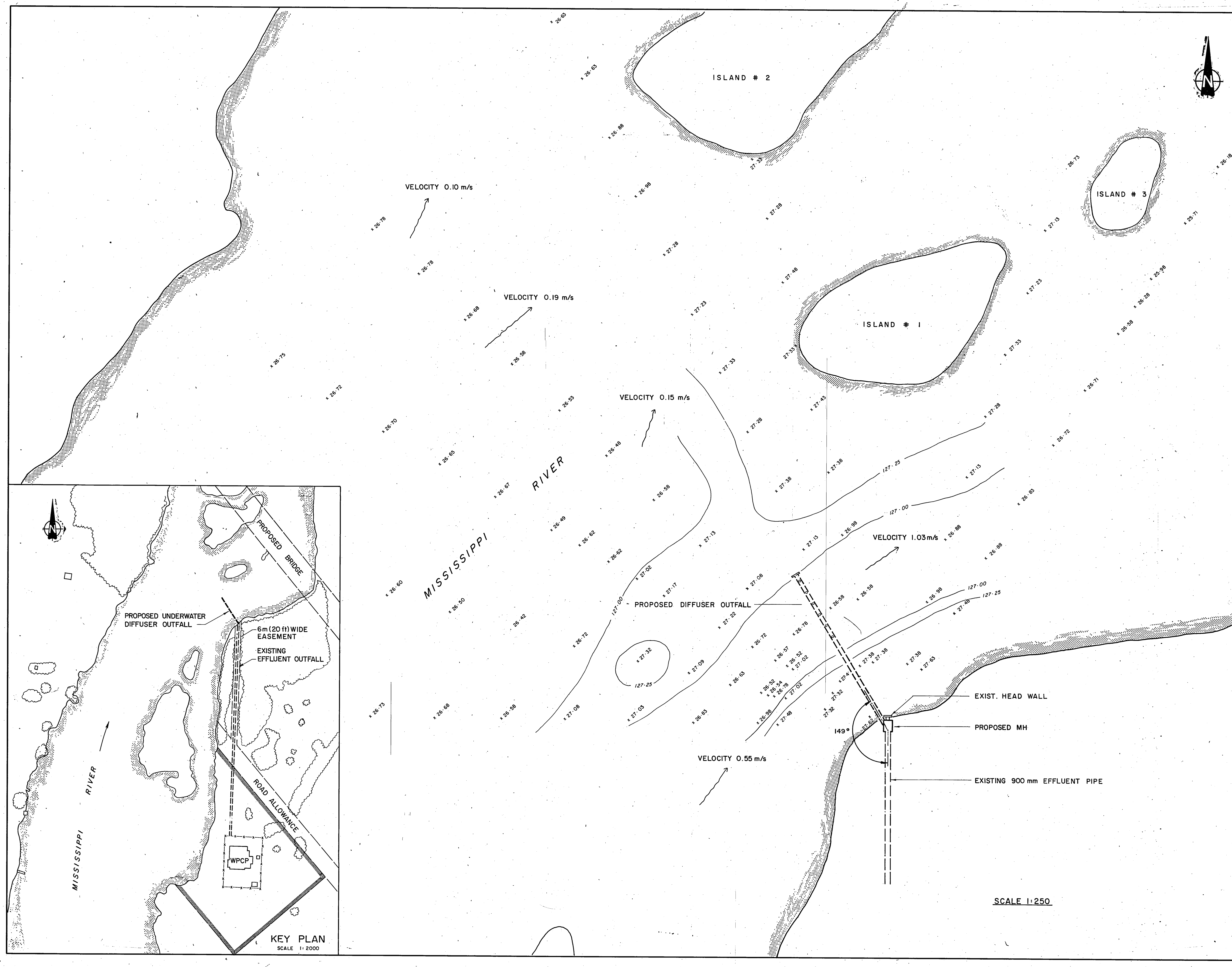
C:\Users\crazafimaharo.CORP\Documents\Local_Work_Tmp\Local-163401646-CarletonPlace\gis\mxd\03_acs\163401646_cp_acs.mxd Revised: 2022-02-14 By: crazafimaharo

Figure 2 - CORMIX Results





Appendix B
Carleton Place WWTP Outfall Design



RIVER WATER LEVELS

SEPT. 13 1990	127·48
OCT. 18 1990	127·62
APR. 10 1991	128·51

BM. ELEV. 128·908
EAST CORNER OF HEAD WALL

VELOCITIES SHOWN WERE MEASURED SEPT. 13, 1990

MISSISSIPPI RIVER DISCHARGE SEPT 13, 1990 – 6·83 m³/s

NO.	REVISION	DATE
4	RECORD DRAWING	20 JAN. '94
3	FOR TENDER	30/1/92
2	FOR APPROVAL	2 DEC. 91
1	FOR OWNER REVIEW	19 JULY 91
NO.	ISSUE	DATE

REGISTERED PROFESSIONAL ENGINEER
CIVIL
S. Van Ingen Schenau
PROVINCE OF ONTARIO

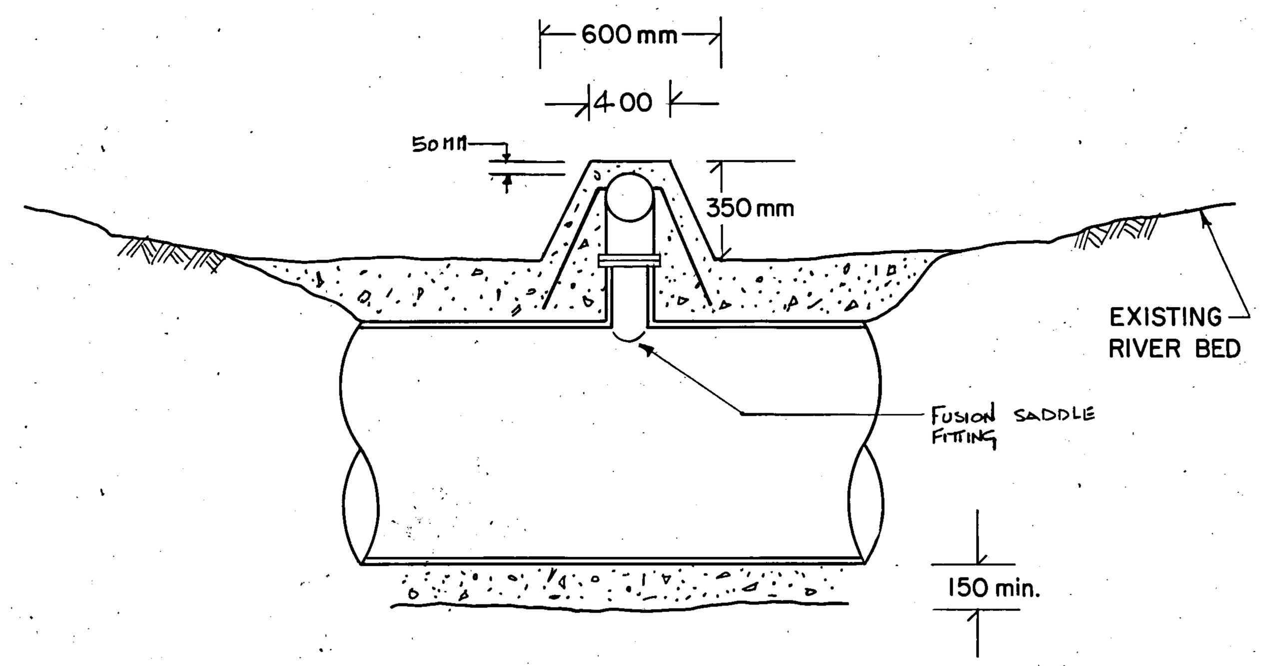
RECORD DRAWING
DATE Jan 20/94

J.L. Richards & Associates Limited
Consulting Engineers, Architects & Planners
OTTAWA, KINGSTON, SUDBURY, CANADA.

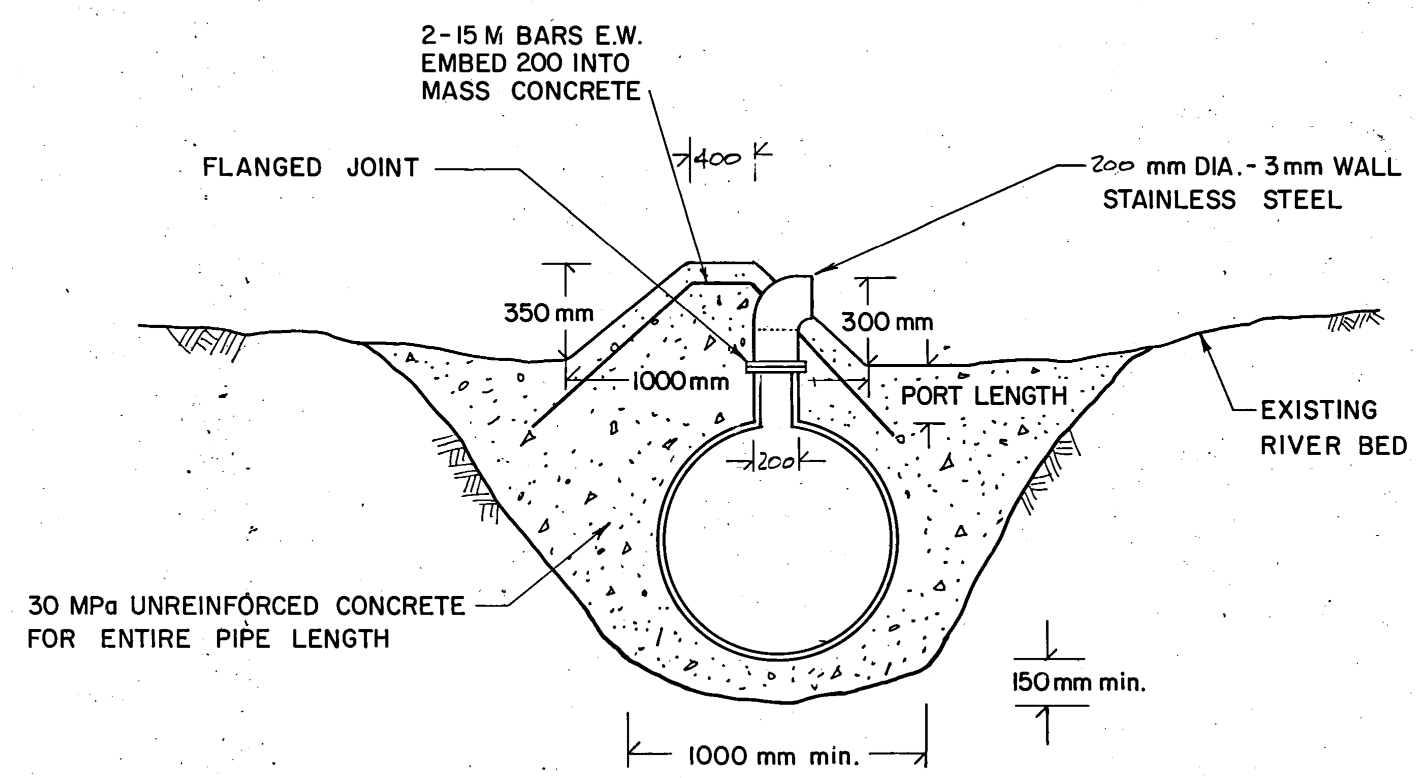
PROJECT:
TOWN OF CARLETON PLACE
WATER POLLUTION CONTROL PLANT
M.O.E. PROJECT 3-0692

DRAWING:
UNDERWATER OUTFALL SEWER - PLAN

DESIGN:	S.A.S.	REVISION NO.:	
DRAWN:	J. H.	DRAWING NO.:	UW - 1
CHECKED:	S.V.I.S.		
DATE:	APRIL 1991		
SCALE:	1 : 250	JOB NO.:	10474



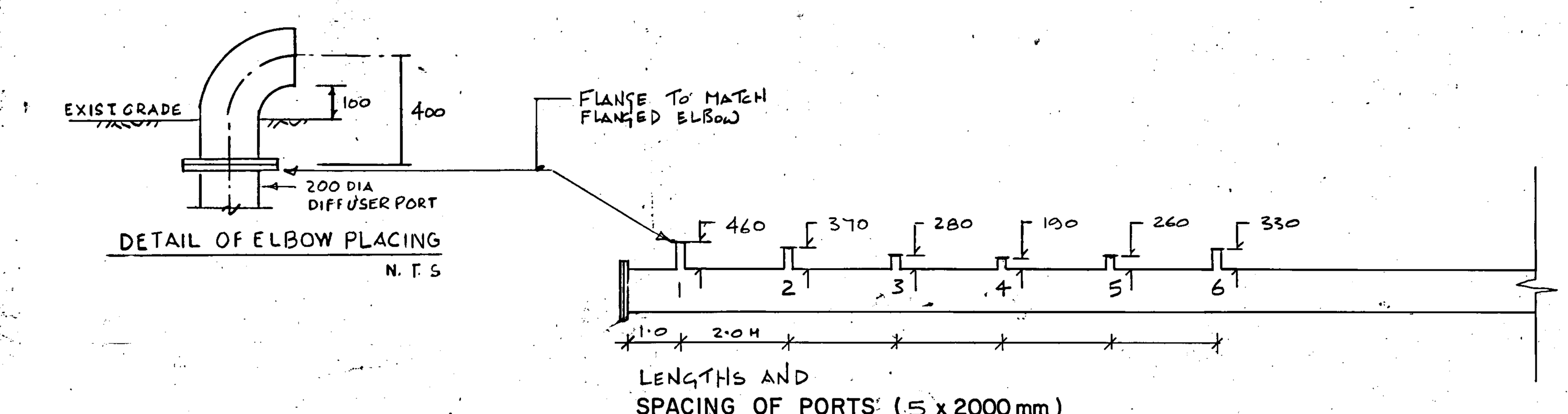
LONGITUDINAL SECTION

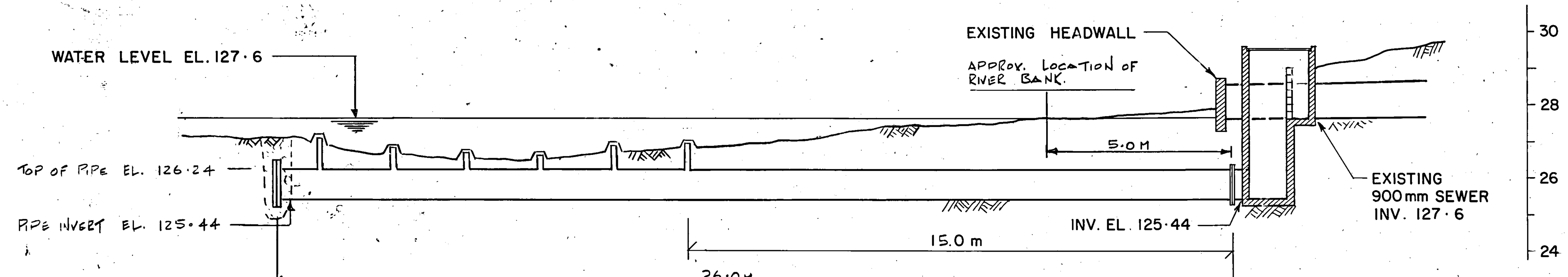


CROSS SECTION

UNDERWATER OUTFALL DETAILS

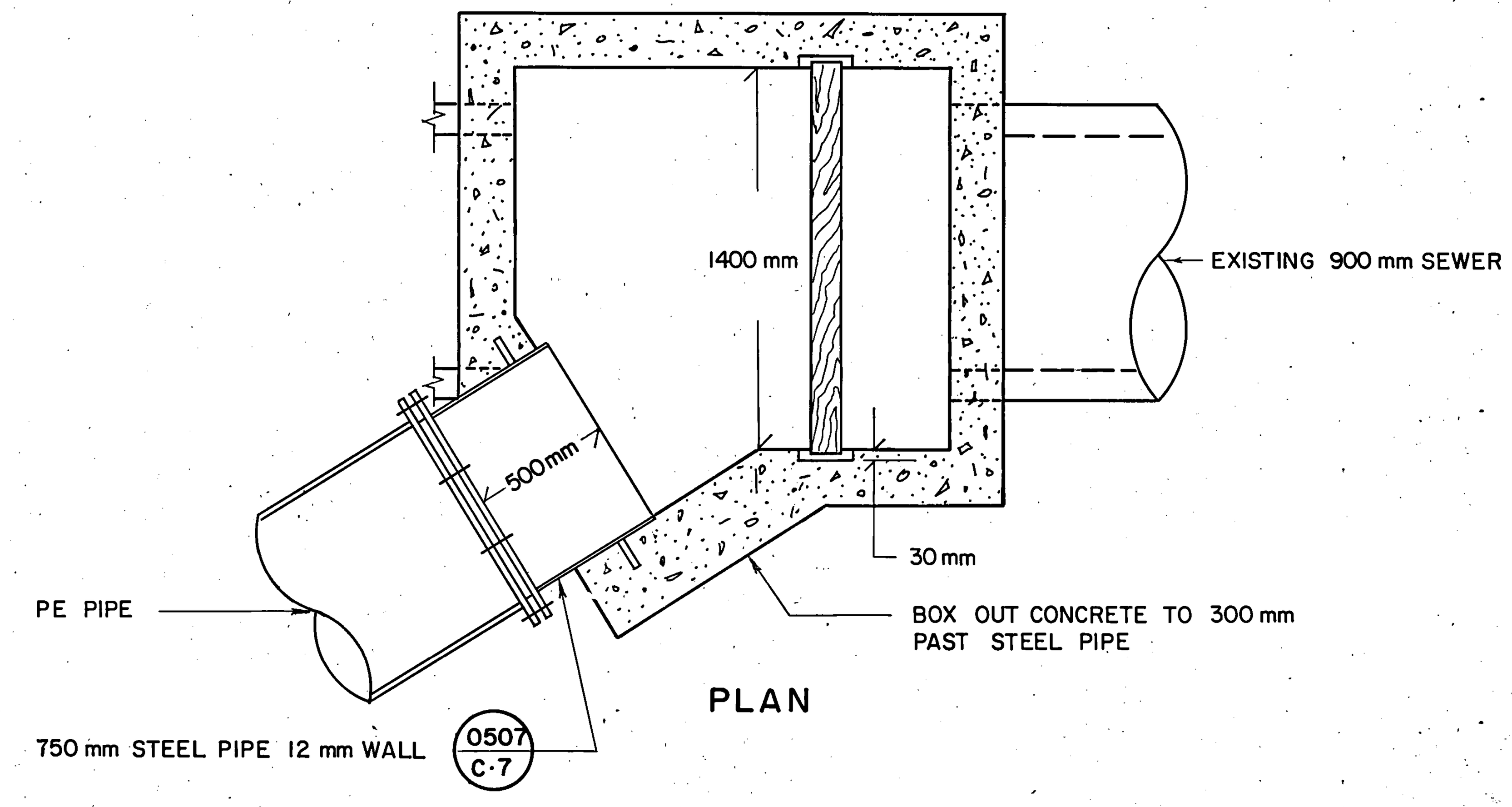
SCALE 1 : 20



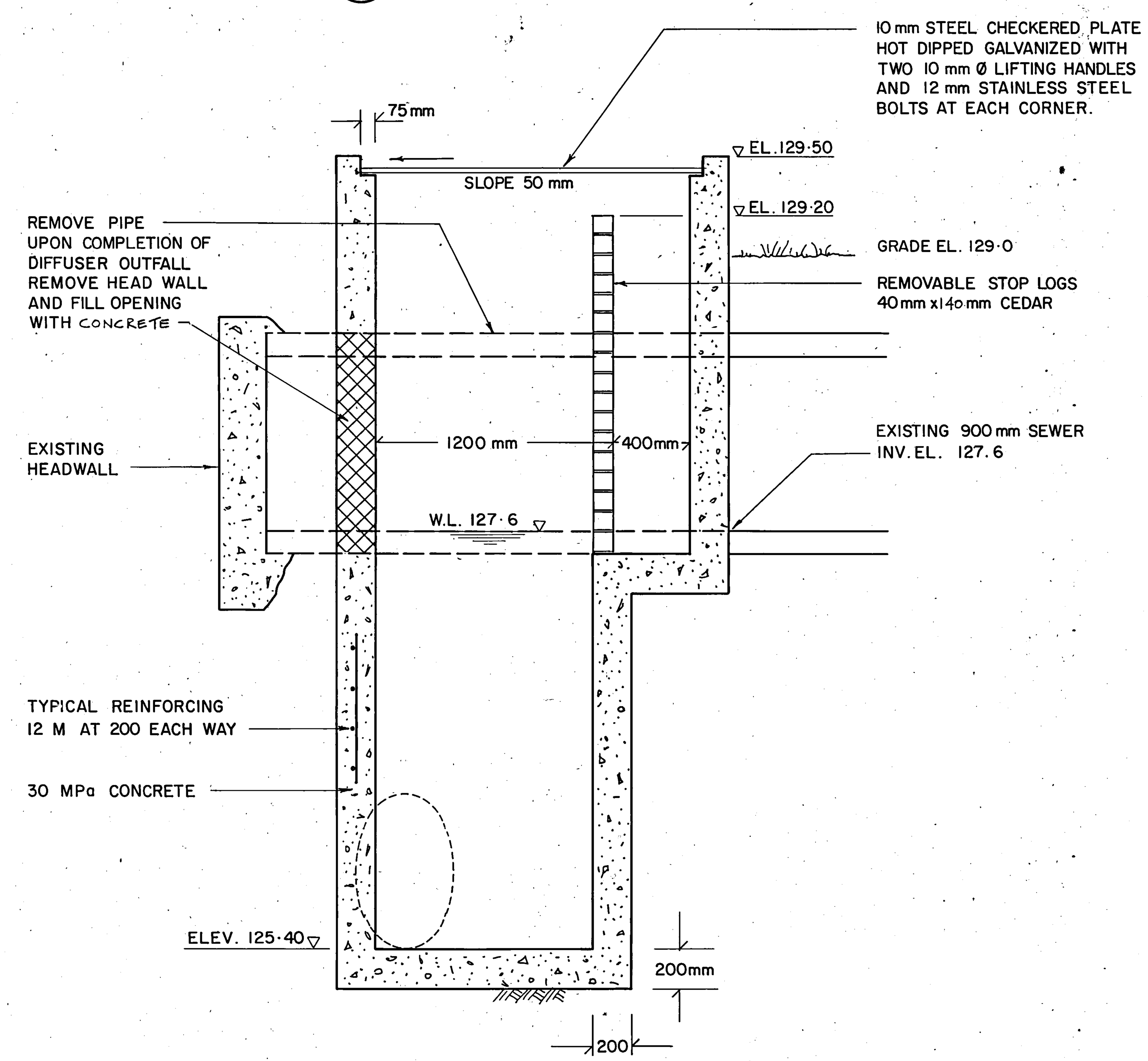


DIFFUSER PROFILE LOOKING DOWNSTREAM

SCALE 1 : 100



PLAN



SECTION

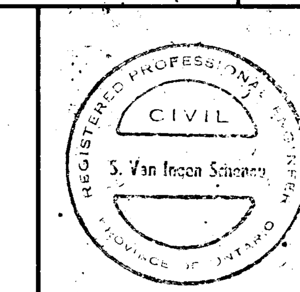
MANHOLE DETAILS

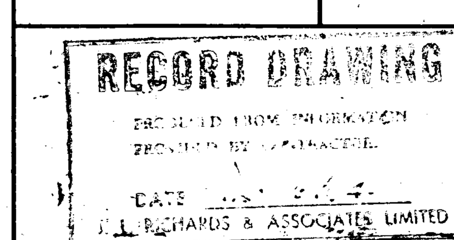
SCALE 1 : 20

NOTES :

1. LOCATE MH BETWEEN TWO EXISTING PIPE JOINTS
2. PE PIPE
   OD 802 mm DIA.
   ID 749 mm DIA.

NO.	REVISION	DATE
4	RECORD DRAWING	20 JAN. 94
3	FOR TENDER	30/1/92
2	FOR APPROVAL	2 DEC. 91
1	FOR OWNER REVIEW	19 JULY 91
NO.	ISSUE	DATE





J.L. Richards & Associates Limited
Consulting Engineers, Architects & Planners
OTTAWA, KINGSTON, SUDBURY, CANADA.

PROJECT:
TOWN OF CARLETON PLACE
WATER POLLUTION CONTROL PLANT
M.O.E. PROJECT 3-0692

DRAWING:
UNDERWATER OUTFALL SEWER - DETAILS

DESIGN:	S.A.S.	REVISION NO.:	
DRAWN:	J. H.	DRAWING NO.:	UW-2
CHECKED:	S.V.I.S.		
DATE:	APRIL 1991		
SCALE:	AS SHOWN	JOB NO.:	10474

Appendix C
Water Quality Downstream of Outfall

APPENDIX C Water Quality Downstream of Outfall

Monthly Average Water Quality for 2017-2021 (PWQMN St. 18343006102)

Month	Total Ammonia Nitrogen (TAN), mg/L	Field pH	Total Phosphorous (TP), mg/L	Total Suspended Solids (TSS), mg/L	Water Temperature, °C	Field Dissolved Oxygen (DO), mg/L
April	0.045	7.95	0.014	2.5	7.3	12.3
May	0.039	8.18	0.013	1.7	16.4	10.7
June	0.044	8.27	0.017	1.5	22.3	9.2
July	0.030	8.61	0.020	2.7	25.3	9.9
August	0.032	8.84	0.016	1.8	22.9	9.0
September	0.027	8.67	0.014	1.7	20.9	9.7
October	0.033	8.00	0.025	5.1	9.9	11.7
November	0.035	7.82	0.014	1.7	2.6	14.5
75^{th} Percent	0.040	8.74	0.017	2.4	22.6	9.4*

Notes:

No data for December-March

– = no data available

* = 25^{th} percentile

Appendix D
Comments and Proponent Responses

COMMENTS AND PROPONENT RESPONSES

Comment No.	Item	MECP Comments – received May 2, 2022	Responses
MECP - 1	**MECP comment received in memorandum dated April 29, 2022** **ECHO #: 1-102258024**	Based on the assimilative capacity study, the parameters of concern will be fully assimilated within a reasonable mixing zone. For example, the modeling results show that CBOD concentrations are reduced to background concentrations within 63 m from the outfall diffusers. However, the consultants indicate that the effects on dissolved oxygen concentrations in the mixing zone is "very small". This may be the case, but the consultants need to model the predicted effects on oxygen concentrations under worse case conditions within the mixing zone.	Detailed dissolved oxygen modeling using an oxygen sag was added to the report. The modelling results indicate that DO decreases from 7.6 mg/L to 6.84 mg/L immediately at the outfall, which is above the PWQO of 4 mg/L. DO slowly increases and reaches the ambient levels 1,050 m downstream of the outfall.
MECP - 2	**MECP comment received in memorandum dated April 29, 2022**	It's not clear if the consultants have based their modeling on the River flow accounting for the increased water to be taken at the Water Treatment Plant.	The 7Q20 was used in this study. This flow is recommended by the MECP Procedure B-1-5 (MOEE 1994) as the low flow statistic for the assessment of receiving waters for point source effluent. It is an extremely low flow which was based on over 100 years of flow records in Appleton (Station ID 02KF006). This flow already incorporates historic water takings at the Water Treatment Plant. The proposed increased water takings were not incorporated in CORMIX because water takings are in fact from a river reach directly connected to Mississippi Lake which has a volume of 6.36 x 10^7 m^3 and outflow from the dam is regulated by an operating rule curve. During low flow conditions, the outflow from the dam will still be maintained regardless of WTP operation. Also, most of the increased water taking at the Water Treatment Plant will return back to the river at the WWTP outfall. Consumptive loss is approximately 13% and that is mostly outdoor water use which eventually returned to the river through baseflow. The Town intends to limit lawn watering and other outdoor water use during extreme drought conditions
MECP - 3	**MECP comment received in memorandum dated April 29, 2022** **ECHO #: 1-102258024**	The consultants should identify if there are any industrial, waste disposal leachates, or other potential sources of contaminants that may pose a risk to effluent quality.	To our knowledge, and confirmed with the municipality, none of the identified sources are present within the vicinity that may cause risk to effluent quality.
MECP - 4	**MECP comment received in memorandum dated April 29, 2022** **ECHO #: 1-102258024**	The consultants have not provided proposed effluent objectives. The Objective for pH should be between 6.5 and 8.5 (as per the PWQO).	Proposed effluent objectives were added to Table 6.2 of the updated AC report. The Objective for pH is between 6.5 and 8.5 (as per the PWQO).
MECP - 5	**MECP comment received in memorandum dated April 29, 2022** **ECHO #: 1-102258024**	The consultants note that the Mississippi River is used for recreational purposes in the area around Carleton Place. If there are public beaches or other drinking water intakes in the vicinity, then the E. coli Effluent Objective should be 100 counts/100 ml.	There are no public beaches or other drinking water intakes in the vicinity of the facility outfall. The Mississippi River is used for recreational purposes in the area around Carleton Place which is upstream of the treatment plan and upstream of the Carleton Place Dam. Recreational use mainly referred to pleasure craft use.

ADDITIONAL MECP COMMENTS

Comment No.	Item	MECP Comments – received June 23, 2022	Responses
MECP - 6	**MECP comment received in email dated June 23, 2022**	The consultants have proposed reasonable final Effluent Objectives	Noted
MECP - 7	**MECP comment received in email dated June 23, 2022**	The consultants have responded to most of the comments in my previous Memo, but did not include a response to my request that the final effluent be non-acutely toxic at the end of pipe. The ECA for this facility should include the condition that the owner operate the facility and maintain the works such that the Final Effluent is non-acutely lethal to Rainbow trout and Daphnia magna as tested in a single sample. Sampling should be conducted quarterly.	Non-acutely toxic effluent is a standard clause in the ECA. The AC study did not assess toxicity as acute toxicity should not exist in the effluent and there is no mixing zone for acute toxicity. We added wording about toxicity limits to the report as suggested by the reviewer.
MECP - 8	**MECP comment received in email dated June 23, 2022**	The Effluent Objective for E. coli should be set at 100 organisms per 100 ml sample.	Noted. Objective updated.
MECP – 9	**MECP comment received in email dated June 23, 2022**	The consultants have not proposed effluent Objectives or Limits for Total Ammonia Nitrogen for the period between October 1 to May 14. The existing ECA and others which discharge to the same receiver contain year-round TAN limits. This needs to be addressed	Winter TAN limits and objectives were added to the report.
MECP – 10	**MECP comment received in email dated June 23, 2022**	Section 6.3 of the report refers to the ECA for the Mississippi Mills Waste Water Treatment Plant. This section does not reference the current ECA Effluent Limits for that facility, but instead references, for comparison purposes, the outdated ECA (2425-8DXR5U) which contains much higher Effluent Limits than permitted under their current ECA (1637-AC8NT7).	Section 6.3 has no impact on the study and was removed to avoid confusion.
MECP - 11	**MECP comment received in email dated June 23, 2022**	I have not reviewed the modelling for this facility. The MVCA reviewer has provided specific comments related to the modelling for the expansion which should be reviewed by an appropriate MECP engineer	Noted

Comment No.	Item	MVCA Comments – Received April 24, 2022	Response
MVCA - 1	**3.1 Receiver Hydrology**	**Report Text:** The Water Survey of Canada (WSC) station on the Mississippi River at Appleton (station ID 02KF006) has monitored flow and water level data since 1918 **Comment:** Low flow measurements @ 02KF006 are known to be inaccurate due to fluctuations at the Appleton Dam and during frazil ice conditions in winter. WSC has been attaching a disclaimer on all flows below 10 cms and flagging them as estimates due to downstream dam activity. The validity of the discharge relationship has also been questioned due to dam backwater effects.	We are aware of this concern, as it was previously discussed with the MVCA. Despite the cautious disclaimer, the Appleton WSC gauge is the best source of historical flow information in the area. There are no other sources of local information that we can rely on. The 7Q20 statistics is very conservative and already incorporates uncertainty of individual flow measurements. Comparison of Appleton flows with Ferguson Falls is of little value as Mississippi Lake is a regulated lake and outflow from the Carlton Place Dam guided by the operating rule curve. In absence of other local flow information, the Appleton gauge #02KF006 with its over 100 years of flow observations is considered adequate for the purpose of this study.

COMMENTS AND PROPONENT RESPONSES

Comment No.	Item	MVCA Comments – Received April 24, 2022	Response
		The Appleton flow data must be used with extreme caution. A cross-correlation with data from Fergusons Falls will help flag inaccurate observations.	
MVCA - 2	**3.1 Receiver Hydrology**	**Report Text:** The five lowest flows on records were observed in 2016, 2001, 1999, 2019 and 2002, and were observed within the last 21 years since the station was installed in 1918. The lowest year on record was 2016 with a 7-day average minimum flow of 2.2 m^3/s. **Comment:** As per MVCA's previous comments, recent data also indicate decreasing trends in minimum 7Q flows - approximately 0.1 cms per decade. Has this been factored into the analysis? Considering the above and our decreasing ability to maintain minimum flows in the system during drought (7Q20) conditions it would have been prudent to include a conservative system 'stress' scenario with the 7Q20 reduced by ~10-15%. It is also noted again that MVCA's 2015 climate change study found that reservoir performance in meeting water level objectives would decrease from the current baseline success rate of 80% to a future success rate of 33% to 53%. The WWTP should therefore look at system vulnerability under current and future water management scenarios and develop resiliency measures for situations when we are unable to replenish storage and/or augment flows. Also refer to "https://mvc.on.ca/wp-content/uploads/2021/05/21APR20-Municipal-Infrastructure.pdf" [21APR20-Municipal-Infrastructure.pdf (mvc.on.ca)]	This Study was conducted in accordance with the MECP Procedure B-1-5. The Procedures are very prescriptive how the 7Q20 flow has to be derived. Statistics for drought condition was modelled under a Log-Pearson Type III distribution using the method of moments, which provides a conservative estimation of drought flows. The increasing or decreasing trend is not factored into this statistical analysis as minimum flows treated as random, independent values. Trend analysis as well as additional "stress analysis" is not part of the MECP Procedure B-1-5. Also, the 7Q20 flow was already reduced from 4.07 m^3/s to 3.88 m^3/s in comparison with the previous AC study. The revised 7Q20 incorporates low flows of the recent extreme years (2016 and 2019). The WWTP is currently looking at system vulnerability under current and future water management scenarios and working on development of resiliency measures for low flow conditions. For example, the Town intends to limit lawn watering and other outdoor water use during extreme drought conditions
MVCA - 3	**3.1 Receiver Hydrology**	**Report Text:** Using GIS and provincial DEM, the difference in drainage area between the WWTP outfall and the Appleton WSC station was determined to be 58 km2. The total area of the Mississippi River watershed at the Appleton WSC station is 2,940 km2. The 7Q20 flow at the WWTP was calculated using an area proration method for the smaller drainage area. The final 7Q20 flow used in this assessment was 3.88 m3/s. **Comment:** I assume this was simple (linear) proration?	Yes, the flow proration was done using a linear relationship. This has been added to the report for clarification.
MVCA - 4	**3.2 Effluent Flow Rate**	**Report Text:** The new proposed maximum daily effluent flow of the upgraded WWTP for any weather conditions is 37,188 m^3/day (0.430 m^3/s). **Comment:** 70% increase in effluent flow, representing 10-15% of the total river flow during 7Q20 conditions and 20% of the minimum flow in 2016. Have you explored opportunities for water reclamation?	Most of the increased water taking at the Water Treatment Plant will return back to the river at the WWTP outfall. Consumptive loss is approximately 13% and that is mostly outdoor water use which eventually returned to the river through baseflow. The Town of Carleton Place is currently looking at various opportunity for water reclamation, for example, the Town intends to limit lawn watering and other outdoor water use during extreme drought conditions The WWTP currently experiences maximum flows greater than 30,000 m3/day. The increase in peak flow is less than 70% as this peak flow is heavily influenced by inflow and infiltration.

Comment No.	Item	MVCA Comments – Received April 24, 2022	Response
MVCA - 5	**3.2 Effluent Flow Rate**	**Report Text:** The proposed discharge location of the six diffusers is not proposed to change with WWTP upgrades. **Comment:** Drawing suggests this is one multi-port diffuser with 6 individual ports. Can the existing diffuser accommodate the increased flow rate or will it be replaced? If existing diffuser is to be used, how will the exit velocities change with the increased effluent flow and is there a potential for river bed scour/erosion.	The diffuser location and design are not proposed to change with the proposed facility upgrades. Existing outfall is a multi-port diffuser with 6 individual ports as presented in Appendix A of the Report. The existing diffuser can accommodate increase in flow. Exit velocity at 0.255 m^3/s is 1.35 m/s. Exit velocity at 0.43 m^3/s is 2.28 m/s. Due to shape and configuration of the diffuser and ports increases in scour and erosion around the diffuser are not expected.
MVCA - 6	**4.1 Receiver Water Quality**	**Report Text:** The Appleton water quality data are presented in **Appendix C** is an indicator of the effectiveness of the current treatment of the Carleton Place WWTP. The Appleton station characterizes water quality in the Mississippi River downstream of the WWTP. **Comment:** This station is located 5 km downstream of the outfall, at this distance effects of the current treatment are fully assimilated.	The Appleton water quality station is representative of water quality downstream of the WWTP. The Mississippi River has sufficient capacity to fully assimilate the effluent from the existing WWTP facility prior to reaching the Appleton station downstream.
MVCA - 7	**4.1 Receiver Water Quality**	**Report Text:** Water quality parameters monitored in Mississippi Lake are limited to pH, phosphorus and water temperature for single samples taken in May, July and September of 2019-2021. TAN, CBOD, TSS, *E.coli* and DO were not sampled in the lake. **Comment:** MVCA does not sample for e.coli on the principal that it is a health unit responsibly, however with running the samples at the Ottawa lab in a package with the City baseline samples, we have been getting e.coli data for the Ferguson's Falls site since 2018. The PWQMN program also does not sample for e.coli out here so there is no data for Appleton. DO and water temperature profile data is sampled in the lake. DO data was not requested by the Stantec team. Only "BOD, TSS, Total Phosphorus, Total Ammonia, pH and temperature" data was requested.	Noted. The required dataset was obtained and utilized for this assessment.
MVCA - 8	**4.1 Receiver Water Quality**	**Report Text:** As data in Mississippi Lake are insufficient to derive statistics for the purpose of this assessment, the water quality data from Fergusons Falls was used to characterize water quality upstream of the WWTP outfall. **Comment:** Fergusons Falls station is located more than 25 km upstream of the outfall. The station does NOT reflect water quality processes in Mississippi Lake which dictate water quality in the river downstream of the lake (pH, nutrients,	As per MECP requirements for the AC studies a reference station should be located upstream of the WWTP outfall location. Ferguson Falls is the closest upstream water quality station with sufficient and representative data. Therefore, Ferguson Falls was used to characterize background conditions in the Mississippi River. Appleton Station was not used as a reference station in the ACS as it is located downstream of the existing WWTP. Water quality at Appleton is representative of assimilated wastewater from the WWTP.

<table>
<tr><th>Comment No.</th><th>Item</th><th>MVCA Comments – Received April 24, 2022</th><th>Response</th></tr>
<tr><td></td><td></td><td>temperature, etc). The Appleton station, although located downstream of the outfall, is much more representative of the ambient water quality conditions in the river and should have been used in combination with available lake data.

Appleton and Ferguon's Falls are sampled once a month for a broad range of field and lab run water quality parameters. The lake is sampled 3 times a year for total phosphorus (lab analyzed), secchi depth, pH and a DO+Water temp profile is taken at each site.</td><td>We compared water quality at Ferguson Falls and Appleton and results are presented below. As expected, Appleton shows an increase in concentrations in comparison with Ferguson Falls. For example: phosphorus increases from 0.013 to 0.016 mg/L, TSS is from 1.8 to 2.3, DO is from 9.9 to 10.9 mg/L and total ammonia from 0.011 to 0.035 mg/L. The use of Appleton data are not expected to significantly change the results of the AC study.

Monthly Average Water Quality for 2019-2021 (Ferguson Falls)
<table>
<tr><th>Month</th><th>Total Ammonia Nitrogen (TAN), mg/L</th><th>Field pH</th><th>Total Phosphorous (TP), mg/L</th><th>Total Suspended Solids (TSS), mg/L</th><th>Water Temperature, °C</th><th>E.Coli - Total (CFU/100ml)</th><th>Field Dissolved Oxygen (DO), mg/L</th></tr>
<tr><td>April</td><td>0.008</td><td>7.46</td><td>0.020</td><td>3</td><td>9.2</td><td>5</td><td>11.1</td></tr>
<tr><td>May</td><td>0.015</td><td>6.98</td><td>0.018</td><td>3.5</td><td>18.6</td><td>13</td><td>8.9</td></tr>
<tr><td>June</td><td>0.012</td><td>7.44</td><td>0.016</td><td>1.5</td><td>21.9</td><td>13</td><td>-</td></tr>
<tr><td>July</td><td>0.010</td><td>6.98</td><td>0.012</td><td>1</td><td>25.0</td><td>9</td><td>7.2</td></tr>
<tr><td>August</td><td>0.013</td><td>6.66</td><td>0.009</td><td>1</td><td>22.9</td><td>11</td><td>7.4</td></tr>
<tr><td>September</td><td>0.012</td><td>7.42</td><td>0.013</td><td>1.67</td><td>17.7</td><td>13</td><td>8.4</td></tr>
<tr><td>October</td><td>0.010</td><td>6.73</td><td>0.011</td><td>1.67</td><td>8.8</td><td>48</td><td>11.2</td></tr>
<tr><td>November</td><td>0.006</td><td>7.46</td><td>0.009</td><td>1</td><td>1.5</td><td>14</td><td>15.0</td></tr>
</table>

Monthly Average Water Quality for 2017-2021 (PWQMN St. 18343006102)
<table>
<tr><th>Month</th><th>Total Ammonia Nitrogen (TAN), mg/L</th><th>Field pH</th><th>Total Phosphorous (TP), mg/L</th><th>Total Suspended Solids (TSS), mg/L</th><th>Water Temperature, °C</th><th>E.Coli - Total (CFU/100ml)</th><th>Field Dissolved Oxygen (DO), mg/L</th></tr>
<tr><td>April</td><td>0.045</td><td>7.95</td><td>0.014</td><td>2.5</td><td>7.3</td><td>-</td><td>12.3</td></tr>
<tr><td>May</td><td>0.039</td><td>8.18</td><td>0.013</td><td>1.7</td><td>16.4</td><td>-</td><td>10.7</td></tr>
<tr><td>June</td><td>0.044</td><td>8.27</td><td>0.017</td><td>1.5</td><td>22.3</td><td>-</td><td>9.2</td></tr>
<tr><td>July</td><td>0.030</td><td>8.61</td><td>0.020</td><td>2.7</td><td>25.3</td><td>-</td><td>9.9</td></tr>
<tr><td>August</td><td>0.032</td><td>8.84</td><td>0.016</td><td>1.8</td><td>22.9</td><td>-</td><td>9.0</td></tr>
<tr><td>September</td><td>0.027</td><td>8.67</td><td>0.014</td><td>1.7</td><td>20.9</td><td>-</td><td>9.7</td></tr>
<tr><td>October</td><td>0.033</td><td>8.00</td><td>0.025</td><td>5.1</td><td>9.9</td><td>-</td><td>11.7</td></tr>
<tr><td>November</td><td>0.035</td><td>7.82</td><td>0.014</td><td>1.7</td><td>2.6</td><td>-</td><td>14.5</td></tr>
</table></td></tr>
<tr><td>MVCA - 9</td><td>4.1 Receiver Water Quality</td><td>Report Text:
Water quality data for 2019-2021 for Fergusons Falls are summarized in Table 4.1 for monthly average and the annual 75th percentile. The annual 75th percentile was calculated based on all available individual samples, not based on monthly averages.

Comment:
How representative the 75th percentiles are when calculated from such a short record.

Can you add number of measurements/data points used in your calculations to all WQ tables.</td><td>Number of samples used to calculate the 75th percentile was added to Table 4.1.

The 75th calculations are representative of the current ambient conditions. For example, 20 sampling events were used to calculate the 75th percentile for TAN, TP, water temperature, and E-coli.

It is a requirement of the Ministry to use the most recent water quality data in AC studies. Therefore, only last three years of water quality data were used. These data are representative for all seasons. There is little value to incorporate old water quality data for the purpose of the ACS. There is a clear historical trend on improving water quality in the river.</td></tr>
</table>

Comment No.	Item	MVCA Comments – Received April 24, 2022	Response
		3 years @ Fergusons is insufficient - another reason to use Appleton which has much longer data record. the Stantec team only requested data for the last three years (2019-2021). -Appleton has been a pwqmn site since 1983 -Mississippi Lake has been sampled almost yearly since 2002 -Ferguson's Falls has been sampled since 2005	
MVCA - 10	**Table 4.1**	**Report Text:** Table 4.1 Monthly Average Water Quality for 2019-2021 (Ferguson Falls) **Comment:** Is there a reason a similar table was not generated from the Appleton data for comparison of current conditions?	Table 4.1 represents reference water quality upstream of the outfall. These data were used in the AC study. Data for Appleton were not used in this study as this station located downstream of the outfall and characterizes "assimilated" water quality. Please see comparison of water quality data for Appleton and Ferguson Falls in MVCA-8
MVCA - 11	**4.1 Receiver Water Quality**	**Report Text:** Monthly average TAN concentrations vary between 0.006 and 0.015 mg/L. Monthly average pH concentrations vary between 6.66 and 7.46. TSS concentrations are generally very low, they vary from 1 to 3.5 mg/L. Water temperature data show expected seasonality with the lowest temperature in winter- spring months and highest in summer months. **Comment:** See previous comments re lake effects on river water quality	See response to Comment MVCA-8.
MVCA - 12	**4.1 Receiver Water Quality**	**Report Text:** Total phosphorus concentrations are below the Provincial Water Quality Objectives (PWQO) (0.03 mg/L for rivers) for all months at both stations. The 75^{th} percentile at Ferguson Fall is 0.016 mg/L. Therefore, the Mississippi River is a Policy 1 receiver with respect to total phosphorus. The Mississippi River is also a Policy 1 receiver for other parameters of concern (i.e., un-ionized ammonia, pH, and *E.coli*). **Comment:** Ferguson Fals data represent Upper Mississippi River. Appleton data should be used to determine Policy for Lower Mississippi River.	See response to Comment MVCA-8.
MVCA - 13	**5.1 Model Input**	**Report Text:** - **Comment:** Can you provide CORMIX input file for review.	Yes – the CORMIX input file is appended to this response submission.
MVCA - 14	**5.1 Model Input**	**Report Text:** The required model inputs for the receiving environment include stream geometry, water temperature, flow, and water depth. Average water depths for the outfall locations and over the plume length were estimated based on available bathymetry information and design drawings (**Appendix B**). **Comment:** Low flow (7Q20) depths, not average flow depths should have been used.	CORMIX has certain limitations regarding a relationship between the port height and water depth. For slightly submerged discharges water depth in CORMIX cannot be less than 3 times of the port height. Therefore, at port height of 0.3 m, the minimum water depth in CORMIX can be 0.9 m. We completed a number of sensitivity tests with lower port heights and lower depth (up to 0.5 m as suggested by the reviewer) and concluded that, in this river setting, reduction of water depth by 0.1 m will increase the extent of the mixing zone by about 10 m. Therefore, in the extreme case, when water depth ever reaches 0.5 m, the mixing zone will increase by about 50 m.

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		Available water column depth is an important near-field mixing parameter and should be accurately estimated. Our 2D model of the river suggests depths of 0.5m or less during low flow conditions.	Despite two different values of water depth in the mixing zone, conclusions of the report remain unchanged: due to optimal configuration of the diffuser and ports the effluent full mixing with ambient water within a very short distance.
MVCA - 15	**5.1 Model Input**	**Report Text:** A Manning's n value of 0.035 was selected for use in the model based on available information about bottom sediments (gravel with small rocks and vegetated banks). **Comment:** MVCA regulatory model for Lower Mississippi River uses n of 0.03.	The CORMIX model inputs have been revised to utilize a Manning's n of 0.03 for consistency with the MVCA regulatory model for the Lower Mississippi River. The extent of the mixing zone has not been changed. The revised CORMIX modeling files are attached to this submission.
MVCA - 16	**5.1 Model Input**	**Report Text:** The receiving water and effluent were assumed to be freshwater with an average annual water temperature of 15.9 degrees Celsius (°C) as per Appleton PWQMN Station 18343006102 (2017-2021). For un-ionized ammonia calculations, the worst-case summer temperature was used as further described in **Section 6.2**. **Comment:** Ideally, assimilative analysis is done for seasonal scenarios capturing different combination of effluent/ambient conditions. Ambient/effluent temperature difference will affect effluent buoyancy. Buoyancy is an important near-field mixing parameter. This parameter should be varied seasonally.	Un-ionized ammonia calculations were conducted for the most conservative conditions, i.e. for the highest monthly observed summer water temperature of 25.0 degree C (in July), highest observed summer pH of 7.44 (in June), and the 75th percentile of total ammonia concentration. As per B-1-5, Assimilative capacity studies should always use worse case conditions, i.e. 7Q20 flow, 75th percentile concentrations, maximum effluent flow rate, maximum effluent concentrations, which is how this study was conducted. The AC study conducted sensitivity analysis of CORMIX with various ambient and effluent temperatures indicated that water temperature and effluent temperature, in a range 0 to 25 degrees C, do not have impact on the results. That occurs because a density differential between effluent and ambient water is very low, water depth is low, jet velocity is high and mixing occurs almost instantaneously.
MVCA - 17	**Table 5.1**	**Report Text:** Table 5.1 CORMIX Input Parameters **Comment:** a. What is the resulting ambient velocity in Cormix assuming rectangular XS? b. Should be depth at 7Q20 c. What is the port exit velocity? d. Horizontal discharge; are the ports oriented perpendicular to the ambient flow?	a. Ambient velocity in CORMIX is 0.097 m/s. Please see CORMIX output files attached. b. See response MVCA -14 c. Port exit velocity is 2.28 m/s d. As shown on Drawing UW-2 of the Carleton Place WWTP Outfall Design (Appendix B), the six discharge ports on the underwater diffuser are all oriented so effluent is discharged parallel to ambient flow, in a downstream direction (horizontal discharge). Port height is 0.3 m.
MVCA - 18	**6.1 CORMIX Results**	**Report Text:** - **Comment:** Can you provide Cormix output file for review. Also, can you comment on the CORMIX flow class.	The CORMIX modeling file and output files are attached to this response submission. Flow Class is CORMIX2 – MU2. Please see the CORMIX output file for more details about this flow class.
MVCA - 19	**6.1 CORMIX Results**	**Report Text:** The effluent is fully mixed with the ambient environment at 63 m from the diffuser. **Comment:** For what effluent/ambient scenario? Average, worst-case?	As per MECP guidelines, the worst case scenario was considered in this AC study i.e. the 7Q20 receiver flow, maximum effluent flow, maximum effluent concentrations and the 75th percentile of water quality in the receiver. Full mixing of the effluent with ambient water is achieved in a near field zone which is 63 m from the outfall.

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		What is the length of near-field mixing zone.	
MVCA - 20	**Table 6.2 Carleton Place WWTP Monthly Average Effluent Limits**	**Report Text:** Total ammonia is the sum of un-ionized ammonia (NH3) and ionized ammonia (NH4). Typically, an equilibrium exists between NH3 and NH4, which is governed by pH and water temperature. In assimilative capacity studies, un-ionized ammonia is of primary interest as it potentially can be toxic in lower concentrations. Other factors which could indirectly affect un-ionized ammonia include water hydraulics (velocities, cross-sections), meteorological conditions and water alkalinity. Highest monthly summer water temperature of 25.0 degree C is observed in July and highest summer pH of 7.44 is observed in June. The 75th percentile total ammonia concentration upstream of the outfall is 0.014 mg/L. Taking into account dilution immediately downstream of the outfall (< 5 m), the maximum total ammonia concentration of the effluent can be as high as 8 mg/L and still result in an un-ionized ammonia concentration below the PWQO (0.02 mg/L N). In order to be conservative and consistent with the existing ECA, it is proposed to keep the **Comment:** See previous comments re river pH. Higher ambient pH will change the equilibrium - increase un-ionized ammonia.	See response to Comment MVCA-8.
MVCA - 21	**Table 6.2 Carleton Place WWTP Monthly Average Effluent Limits**	**Report Text:** Table 6.2 Carleton Place WWTP Monthly Average Effluent Limits **Comment:** Concerning TAN increase - can you comment on this. My instincts find it concerning that they are proposing a near doubling of the loading value, as this may consume a lot of precautionary buffer in the system.	Considering the worst case summer conditions, the maximum total ammonia concentration of the effluent can be as high as 8 mg/L and still result in an un-ionized ammonia concentration below the PWQO (0.02 mg/L N) in the immediate mixing zone. In order to be conservative and consistent with the existing ECA, it was proposed to keep the summer TAN limits the same as in the current ECA, i.e., 4 mg/L N. The maximum load at is concentration is 148 kg/day. These limits are protective of the environment.
MVCA - 22	**Table 6.3 Mississippi Mills WWTP Effluent Limits**	**Report Text:** Table 6.3 Mississippi Mills WWTP Effluent Limits **Comment:** Table 6.3 doesn't use the same date ranges as Table 6.2 so comparing what the Almonte facility is permitted to do, to the proposal for the CP facility is challenged.	Table 6.3 presents the ECA effluent limits of the Mississippi Mills WWTP. This table was included for comparison and illustrative purposes in response to a reviewer request. The limits for Almonte facility did not impact the results of this AC study.

ADDITIONAL COMMENTS

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MVCA – 23	**3.1 Receiver Hydrology**	**Response to MVCA-2:** Trend analysis as well as additional "stress analysis" is not part of the MECP Procedure B-1-5. **Comment:** Procedure B-1-5 provides general guidelines for deriving 7Q20 flows. Any site-specific conditions should be factored into the analysis. If data shows trends,	The Procedure B-1-5 used in this study meets MECP expectations for the ACS as it includes a stress test that applies four different extreme conditions: extremely low receiver flow (7Q20), high receiver concentration (75th percentile), high effluent concentration, and peak effluent flow, simultaneously. No changes will be made to the ACS as it follows the guidelines and regulations set out by the MECP.

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		they cannot be ignored, nor standard frequency analysis used, as the assumption of stationarity is no longer valid. B-1-5 does not provide detailed directions for specific situations like this but it is the responsibility of the engineer to consider all site-specific aspects and apply appropriate methodology in the analysis.	Based on discussion in a meeting with MVCA on July 26, 2022, Stantec will prepare a separate sensitivity analysis memo, where the 7Q20 will be reduced by 10% and the 75th percentile of baseline water quality will be increased by 18% for total ammonia and total phosphorus to examine sensitivity of extreme low flow and high receiver concentrations.
MVCA - 24	**3.1 Receiver Hydrology**	**Response to MVCA-2:** Also, the 7Q20 flow was already reduced from 4.07 m3/s to 3.88 m3/s in comparison with the previous AC study. **Comment:** This only confirms that the 7Q20 has been decreasing and provides another reason to expect the current 7Q20 value (3.88 cms) will also decrease in time and as such may not be representative of all future time horizons for which the Master Plan is being prepared. It is also noted that the river flow upstream of the outfall will be further reduced by the increased extraction rate (20,700 m3/d) which represents more than 10% of the historic low flow. Finally, it is noted that the outflow from the Carleton Place Water Control Structure is not regulated during low flow conditions	See response to MVCA-23 above.
MVCA - 25	**3.2 Effluent Flow Rate**	**Response to MVCA-5:** Exit velocity at 0.255 m3/s is 1.35 m/s. Exit velocity at 0.43 m3/s is 2.28 m/s. Due to shape and configuration of the diffuser and ports increases in scour and erosion around the diffuser are not expected. **Comment:** This is a significant (70%) increase in effluent exit velocity. Has STANTEC verified the channel substrate in the vicinity of the discharge?	Although exit velocity is increasing, it is still within an acceptable design range for outfalls. This increased velocity is not expected to cause erosion around the diffuser. Prior to expansion, Stantec will recommend inspecting the outfall, which will also check for any existing evidence of scour and erosion.
MVCA - 26	**4.1 Receiver Water Quality**	**Response to MVCA-6:** The Appleton water quality station is representative of water quality downstream of the WWTP. The Mississippi River has sufficient capacity to fully assimilate the effluent from the existing WWTP facility prior to reaching the Appleton station downstream. **Comment:** While we agree with the response, it does not address the original comment. The Appleton water quality data can be considered representative of the water quality in the Mississippi River at Appleton, however, it is 5 km downstream of the WWTP and is thus unlikely to be a good indicator of the effectiveness of the WWTP, as the effluent is fully assimilated over this distance. Note that the original text stated “The Appleton water quality data presented in Appendix C is an indicator of the effectiveness of the current treatment of the Carleton Place WWTP.”	See response to MVCA-23 above. Sentence about “the effectiveness of the WWTP” was removed.
MVCA - 27	**4.1 Receiver Water Quality**	**Response to MVCA-8:** As data in Mississippi Lake are insufficient to derive statistics for the purpose of this assessment, the water quality data from Fergusons Falls was used to characterize water quality upstream of the WWTP outfall. **Comment:**	See response to MVCA-23 above

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		As per our previous comments, MVCA is not supportive of the use of Fergusons Falls station for ambient characterization as this station is located more than 25 km upstream of the outfall (and upstream of Mississippi Lake) and is not representative of the water quality in the river downstream of the Lake (where the outfall is located). In situations when ambient water quality data is insufficient or missing, a monitoring program is typically established to collect additional/ confirmatory data in support of the assimilative capacity study	
MVCA - 28		**Comment:** A number of assumptions have been made in the assimilative capacity study. While individually they may not have critical effects on the presented results, their combined effect may be significant. Considering the above the MVCA asks that a "stress scenario" is included in the analysis, addressing the above noted concerns related to ambient water quantity and quality characterization, and demonstrating that the effluent limits are protective of the environment during the entire time horizon serviced by the Master Planning Study.	See response to MVCA-23 above